

**WHAT IS CLAIMED IS:**

1. A method of ameliorating a dermatological condition in the skin of a mammal, comprising:

5 administering a composition comprising a substituted fullerene to at least a portion of the skin of the mammal afflicted with the dermatological condition or potentially afflicted with the dermatological condition, wherein the substituted fullerene comprises a fullerene core (C<sub>n</sub>) and at least one of:

- (i) from 1 to 3 (>CX<sup>1</sup>X<sup>2</sup>) groups bonded to the fullerene core;
- 10 (ii) from 1 to 18 -X<sup>3</sup> groups bonded to the fullerene core;
- (iii) from 1 to 6 -X<sup>4</sup>- groups bonded to the fullerene core; or
- (iv) from 1 to 6 dendrons bonded to the fullerene core.

2. The method of claim 1, wherein the substituted fullerene comprises a fullerene core (C<sub>n</sub>) having 60 carbon atoms or 70 carbon atoms.

3. The method of claim 1, wherein each X<sup>1</sup> and X<sup>2</sup> is independently selected from -H, -COOH, -CONH<sub>2</sub>, -CONHR', -CONR'<sub>2</sub>, -COOR', -CHO, -(CH<sub>2</sub>)<sub>d</sub>OH, -R, -RCOOH, -RCONH<sub>2</sub>, -RCONHR', -RCONR'<sub>2</sub>, -RCOOR', -RCHO, -R(CH<sub>2</sub>)<sub>d</sub>OH, or a salt thereof, 20 wherein each R is a hydrocarbon moiety having from 1 to about 6 carbon atoms and each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid, and d is an integer from 0 to about 20.

25 4. The method of claim 1, wherein the substituted fullerene comprises C<sub>60</sub> and 3 (>CX<sup>1</sup>X<sup>2</sup>) groups in the C3 orientation or the D3 orientation.

5. The method of claim 1, wherein the substituted fullerene comprises C<sub>60</sub> and 2 (>CX<sup>1</sup>X<sup>2</sup>) groups in the trans-2 orientation, the trans-3 orientation, the e orientation, or 30 the cis-2 orientation.

6. The method of claim 1, wherein the substituted fullerene comprises C<sub>70</sub> and 2 (>CX<sup>1</sup>X<sup>2</sup>) groups in the bis orientation.

5 7. The method of claim 1, wherein the substituted fullerene has the structure shown in Figure 8B.

8. The method of claim 1, wherein the substituted fullerene comprises from 1 to about 6 -X<sup>3</sup> groups and each -X<sup>3</sup> group is independently selected from:

10 -N<sup>+</sup>(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>4</sup>), wherein R<sup>2</sup>, R<sup>3</sup>, and R<sup>4</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20;

-N(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>8</sup>), wherein R<sup>2</sup> and R<sup>3</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and each R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>,

-(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20;

15 -C(R<sup>5</sup>)(R<sup>6</sup>)(R<sup>7</sup>), wherein R<sup>5</sup>, R<sup>6</sup>, and R<sup>7</sup> are independently -COOH, -H, -CH(=O), or -CH<sub>2</sub>OH;

-C(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>8</sup>), wherein R<sup>2</sup> and R<sup>3</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and each R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>,

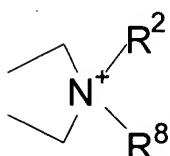
-(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20;

20 -(CH<sub>2</sub>)<sub>e</sub>-COOH, -(CH<sub>2</sub>)<sub>e</sub>-CONH<sub>2</sub>, -(CH<sub>2</sub>)<sub>e</sub>-COOR', or a peptidyl moiety, wherein e is an integer from 1 to about 6 and each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid; or

an aromatic heterocyclic moiety containing a cationic nitrogen.

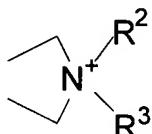
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9. The method of claim 1, wherein each -X<sup>4</sup>- group is independently



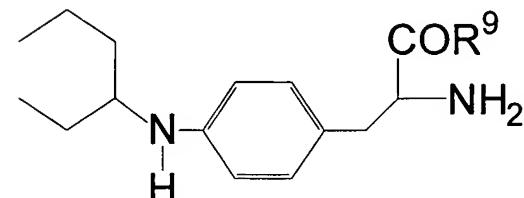
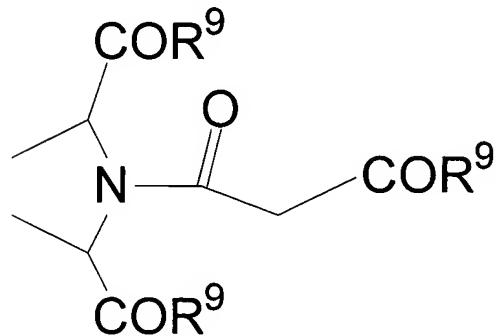
, wherein R<sup>2</sup> is independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an

integer from 0 to about 20, and R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>, -(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20.

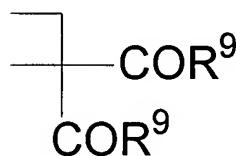


10. The method of claim 1, wherein each -X<sup>4</sup>- group is independently  
5 wherein each R<sup>2</sup> and R<sup>3</sup> is independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20.

11. The method of claim 1, wherein each -X<sup>4</sup>- group is independently

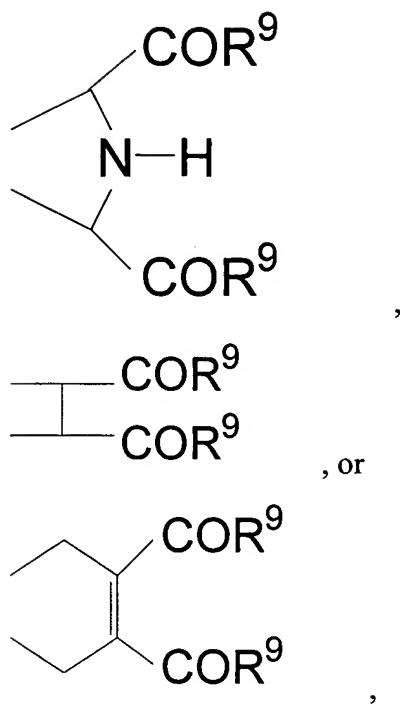


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5       wherein each R<sup>2</sup> is independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and each R<sup>9</sup> is independently -H, -OH, -OR', -NH<sub>2</sub>, -NHR', -NHR'<sub>2</sub>, or -(CH<sub>2</sub>)<sub>d</sub>OH, wherein each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid.

10      12.     The method of claim 1, wherein the substituted fullerene has a structure selected from Figures 9A-9G.

13.     The method of claim 1, wherein the substituted fullerene comprises an endohedral metal.

15      14.     The method of claim 1, wherein the composition further comprises an amphiphilic fullerene having the formula (B)<sub>b</sub>-C<sub>n</sub>-(A)<sub>a</sub>, wherein C<sub>n</sub> is a fullerene moiety comprising n carbon atoms, wherein n is an integer and 60 ≤ n ≤ 240; B is an organic moiety comprising from 1 to about 40 polar headgroup moieties; b is an integer and 1 ≤ b ≤ 5; 20     each B is covalently bonded to the C<sub>n</sub> through 1 or 2 carbon-carbon, carbon-oxygen, or

carbon-nitrogen bonds; A is an organic moiety comprising a terminus proximal to the C<sub>n</sub> and one or more termini distal to the C<sub>n</sub>, wherein the termini distal to the C<sub>n</sub> each comprise -C<sub>x</sub>H<sub>y</sub>, wherein x is an integer and 8 ≤ x ≤ 24, and y is an integer and 1 ≤ y ≤ 2x+1; a is an integer, 1 ≤ a ≤ 5; 2 ≤ b+a ≤ 6; and each A is covalently bonded to the C<sub>n</sub> through 1 or 2 carbon-carbon, carbon-oxygen, or carbon-nitrogen bonds.

15. The method of claim 1, wherein the dermatological condition is sunburn, aging, psoriasis, acne, or smoker's face.

10 16. A composition for ameliorating a dermatological condition in the skin of a mammal, comprising:

a substituted fullerene; and

a carrier

wherein the substituted fullerene comprises a fullerene core (C<sub>n</sub>) and at least one 15 of:

(i) from 1 to 3 (>CX<sup>1</sup>X<sup>2</sup>) groups bonded to the fullerene core;

(ii) from 1 to 18 -X<sup>3</sup> groups bonded to the fullerene core;

(iii) from 1 to 6 -X<sup>4</sup>- groups bonded to the fullerene core; or

(iv) from 1 to 6 dendrons bonded to the fullerene core.

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17. The composition of claim 19, wherein each X<sup>1</sup> and X<sup>2</sup> is independently selected from -H, -COOH, -CONH<sub>2</sub>, -CONHR', -CONR'₂, -COOR', -CHO, -(CH<sub>2</sub>)<sub>d</sub>OH, -R, -RCOOH, -RCONH<sub>2</sub>, -RCONHR', -RCONR'₂, -RCOOR', -RCHO, -R(CH<sub>2</sub>)<sub>d</sub>OH, or a salt thereof, wherein each R is a hydrocarbon moiety having from 1 to about 6 carbon atoms and each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid, and d is an integer from 0 to about 20.

25 18. The composition of claim 16, wherein the substituted fullerene has the structure shown in Figure 8B.

19. The composition of claim 16, wherein the substituted fullerene comprises from 1 to about 6 -X<sup>3</sup> groups and each -X<sup>3</sup> group is independently selected from:

-N<sup>+</sup>(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>4</sup>), wherein R<sup>2</sup>, R<sup>3</sup>, and R<sup>4</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>,

5 wherein d is an integer from 0 to about 20;

-N(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>8</sup>), wherein R<sup>2</sup> and R<sup>3</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20; and each R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>,

-(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20;

-C(R<sup>5</sup>)(R<sup>6</sup>)(R<sup>7</sup>), wherein R<sup>5</sup>, R<sup>6</sup>, and R<sup>7</sup> are independently -COOH, -H, -CH(=O),

10 or -CH<sub>2</sub>OH;

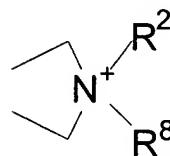
-C(R<sup>2</sup>)(R<sup>3</sup>)(R<sup>8</sup>), wherein R<sup>2</sup> and R<sup>3</sup> are independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and each R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>,

-(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20;

15 -(CH<sub>2</sub>)<sub>e</sub>-COOH, -(CH<sub>2</sub>)<sub>e</sub>-CONH<sub>2</sub>, -(CH<sub>2</sub>)<sub>e</sub>-COOR', or a peptidyl moiety, wherein e is an integer from 1 to about 6 and each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid; or

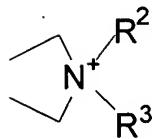
an aromatic heterocyclic moiety containing a cationic nitrogen.

20 20. The composition of claim 16, wherein each -X<sup>4</sup>- group is independently



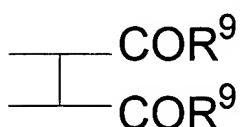
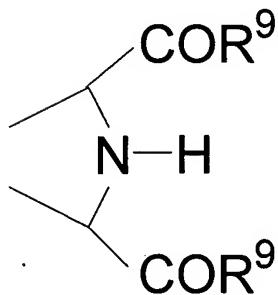
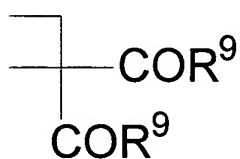
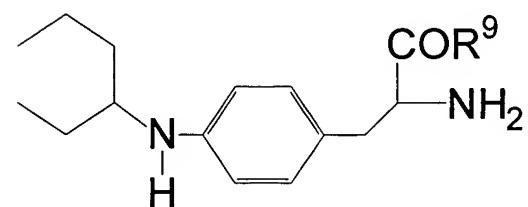
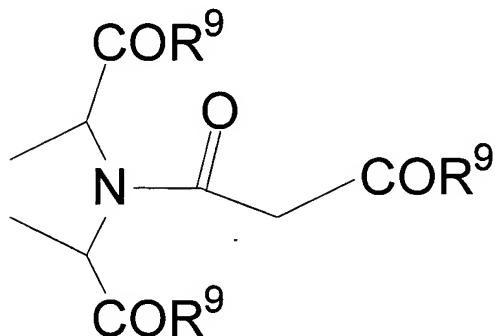
, wherein R<sup>2</sup> is independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and R<sup>8</sup> is independently -(CH<sub>2</sub>)<sub>f</sub>SO<sub>3</sub><sup>-</sup>, -(CH<sub>2</sub>)<sub>f</sub>PO<sub>4</sub><sup>-</sup>, or -(CH<sub>2</sub>)<sub>f</sub>COO<sup>-</sup>, wherein f is an integer from 1 to about 20.

21. The composition of claim 16, wherein each  $-X^4-$  group is independently



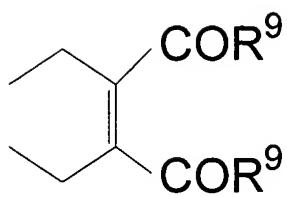
, wherein each  $R^2$  and  $R^3$  is independently  $-H$  or  $-(CH_2)_d-CH_3$ , wherein  $d$  is an integer from 0 to about 20.

5 22. The composition of claim 16, wherein each  $-X^4-$  group is independently



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, or



wherein each R<sup>2</sup> is independently -H or -(CH<sub>2</sub>)<sub>d</sub>-CH<sub>3</sub>, wherein d is an integer from 0 to about 20, and each R<sup>9</sup> is independently -H, -OH, -OR', -NH<sub>2</sub>, -NHR', -NHR'<sub>2</sub>, or -(CH<sub>2</sub>)<sub>d</sub>OH, wherein each R' is independently (i) a hydrocarbon moiety having from 1 to about 6 carbon atoms or (ii) a hydrocarbon moiety having from 1 to about 6 carbon atoms and a terminal carboxylic acid.

23. The composition of claim 16, wherein the substituted fullerene has a structure selected from Figures 9A-9G.